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ALIST Update:
LITER - LIThium EvaporatoR for NSTX and Progress on Modeling and Experiment at UCLA

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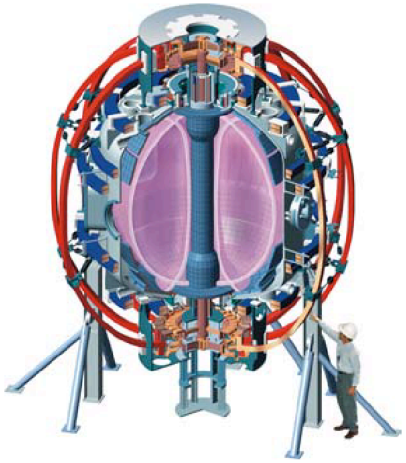

Plasma Facing Components Electronic Meeting
November 2, 2005
Princeton, NJ

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Outline

- Lithium Evaporator for NSTX:

1) Motivation and Goal
2) Schematic of LITER
3) Installation on NSTX
4) LITER Schedule
5) Outstanding Issues
6) Summary

- Modeling and Experiment at UCLA:

1) Progress on HIMAG Simulations
2) Update on QTOR Facility
3) Future Plans

Motivation and Goal

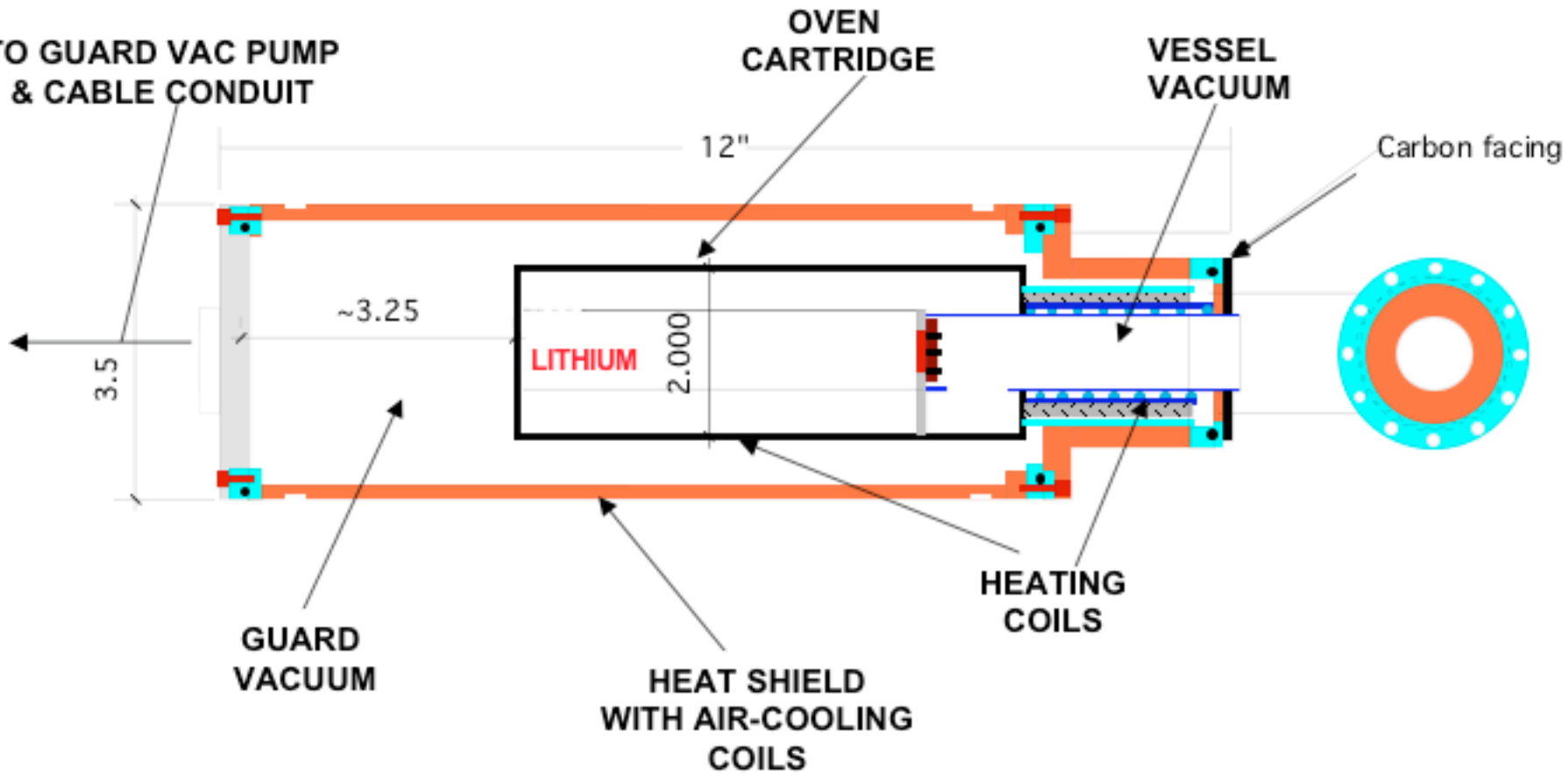
- A partial lithium coating on carbon PFCs has been demonstrated to provide strong edge pumping (reduction of recycling) - recent NSTX results summarized earlier in electronic meeting

- The NSTX 5-Year Plan describes a 3 phased approach to lithium PFCs: (I) Lithium Pellet Injection, (II) Lithium Evaporators - "ALIST Module A,"(III) Liquid Lithium Divertor - "ALIST Module B"

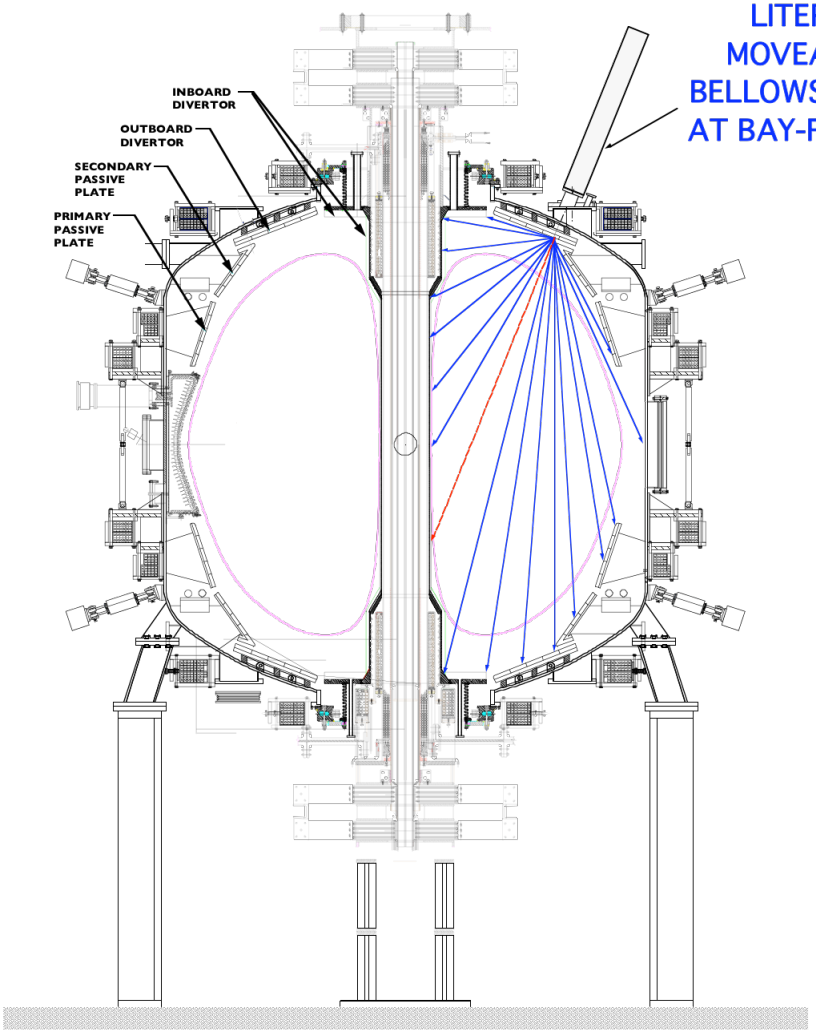
- Phase I, Lithium Pellet Injection is in progress; Phase II is starting.

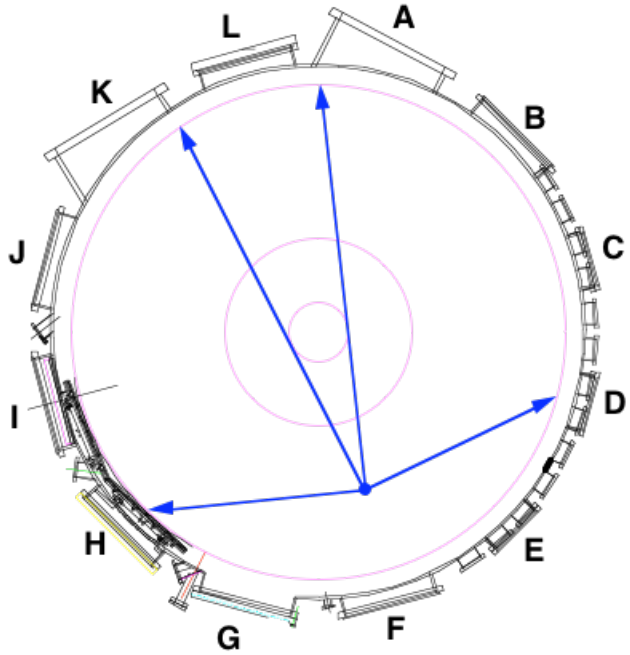
- The NSTX Experimental Schedule calls for the capability to perform routine Thick Lithium Coating depositions over a significant fraction of the plasma facing surfaces for the first XP's in 2006.

Schematic of LITER



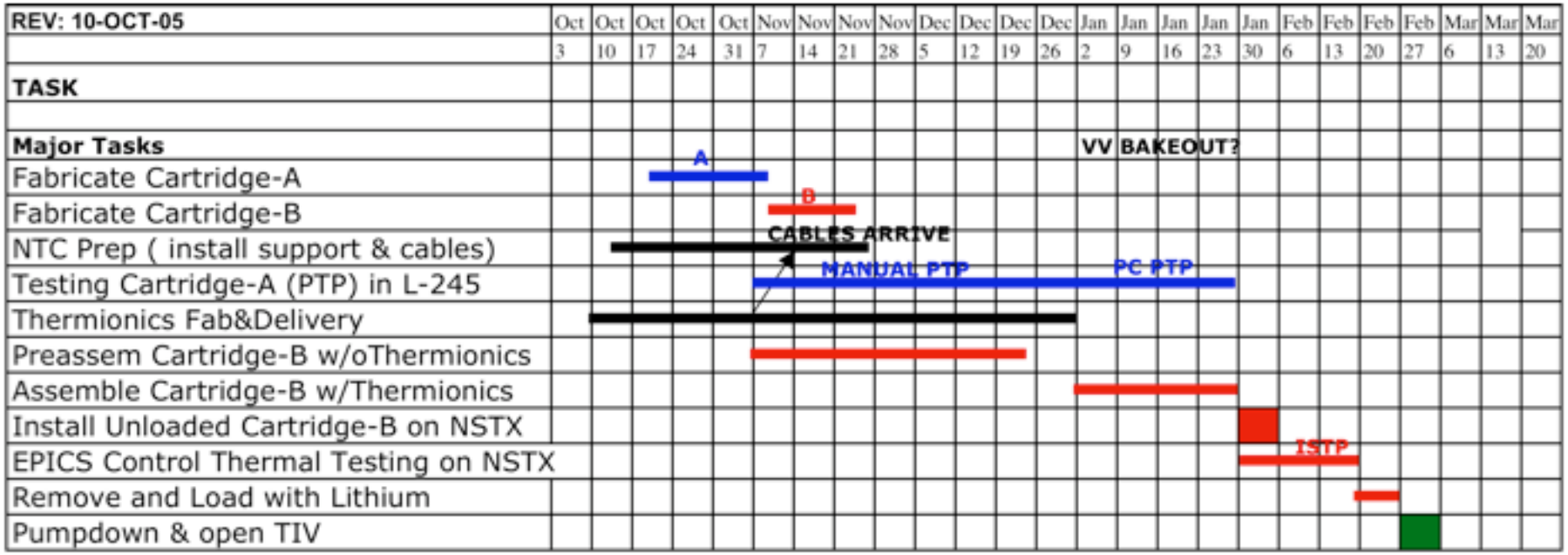
Installation on NSTX





- Wide coverage over CS and Inner divertors for high performance DND plasmas.
- Thick deposition on Lower Divertor for LSN plasmas.

LITER Schedule



Outstanding Issues

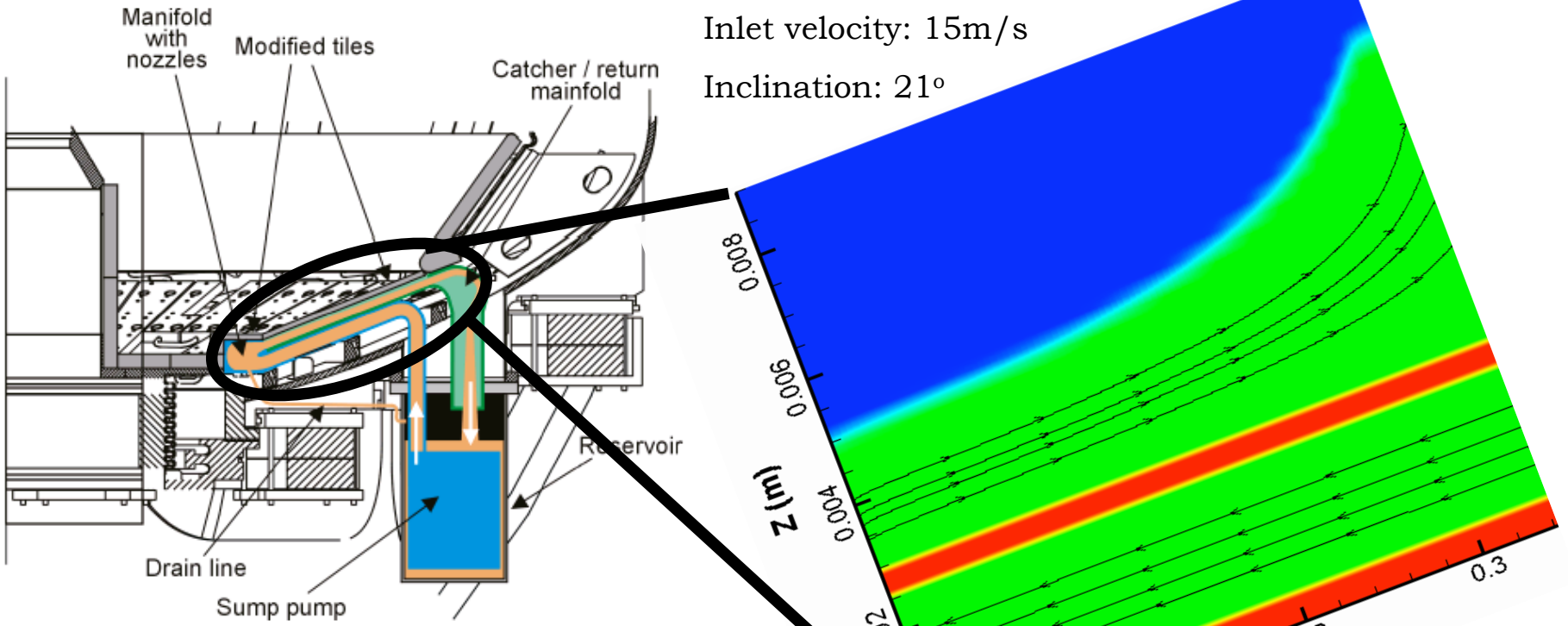
- Safe lithium handling and ES&H issues
- Safe NSTX vacuum vessel venting and entrance procedures
- Proposed procedures for possible LITER maintenance problems
- Appropriate engineering interlocks
- Machine internal effects
    - Windows (open and shuttered)
    - Insulators (CHI, RF, Filament Holders)
    - Shutter motion
- Physics effects
    - Inadequate fueling capability due to low recycling
    - Wall conditioning requirements (HeGDC, Boronization)

Summary

- Prototype of LITER has been demonstrated successfully offline and on CDX-U
  - Used to obtain low-recycling plasmas in CDX-U
  - Sufficient operating experience to proceed to installation of LITER on NSTX
- NSTX LITER intended to be installed and available for the used in experimental proposals early in 2006 run
  - Present plans calls for at least 12 run weeks instead of *no* operations in FY06 under earlier budget guidance

UCLA free surface MHD update for ALIST

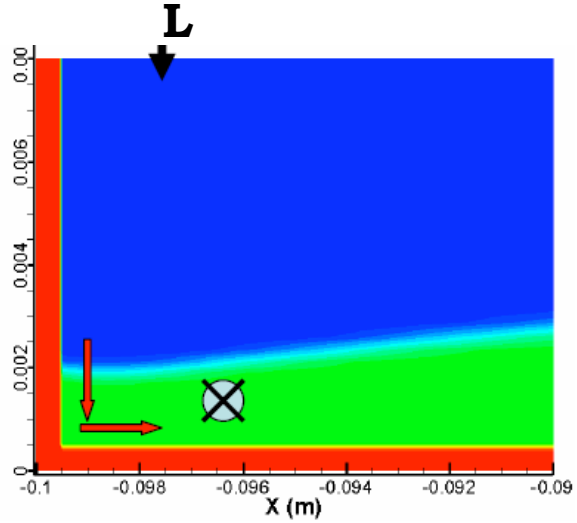
Begun HIMAG simulation of the free surface lithium film flow, with electromagnetic coupling to the feeder channel flow in complete NSTX outboard divertor magnetic field.

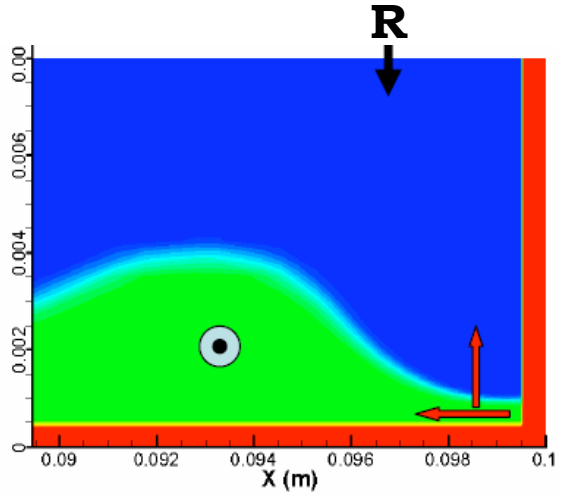


The stream wise section cut at the center of the channel. The red region represents the solid conductor. The middle separator plate thickness used was 0.5 mm. Green shows the lithium film and blue represents the background gas.

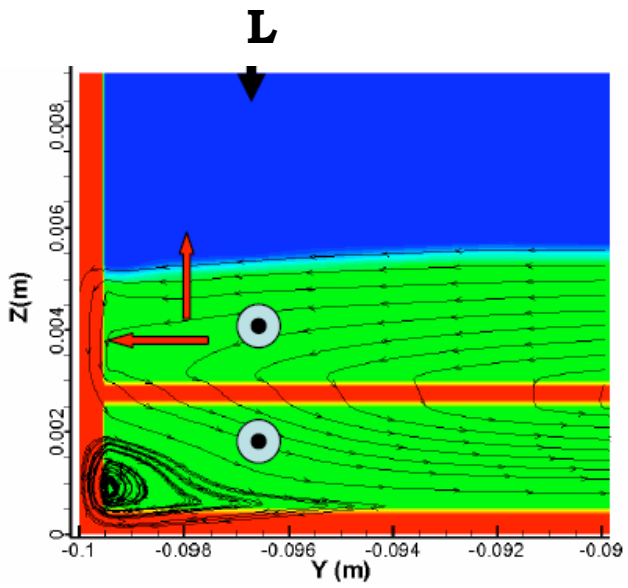
The velocity streamlines are shown. Film thickness increases from 2mm to 4.5 mm at the outboard at the center of the channel.

Axial current distribution in the lithium film is reversed by electromagnetic coupling with bottom feeder channel MHD flow. The side wall detachment effect observed in simulations without the bottom feeder channel is no longer present!

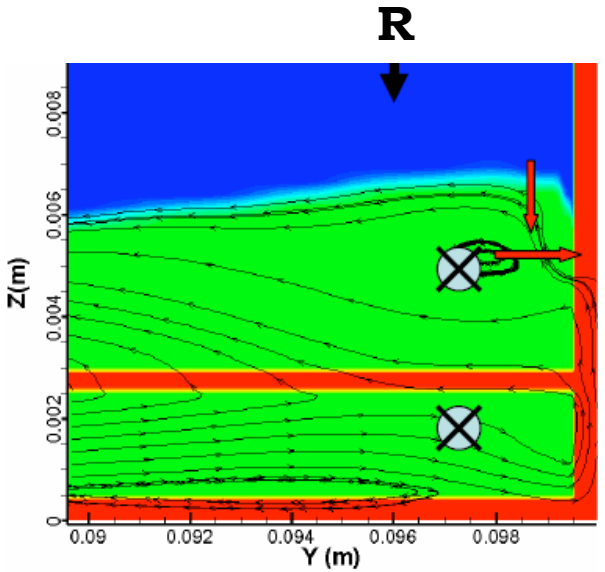


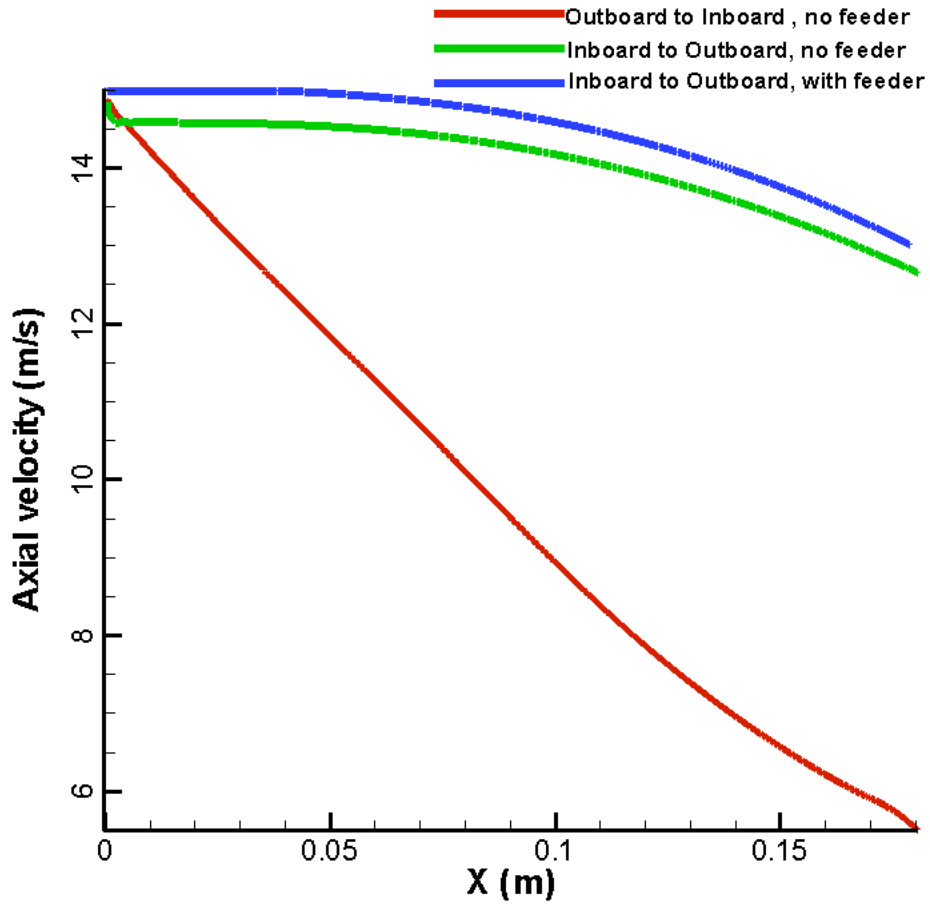


Span wise cross sections cut at 20*cm* downstream. The regions close to the left and right side walls are shown. The red arrows mark the direction of the cross sectional MHD force acting on the lithium film due to the induced axial currents, which point into or out of the plane as indicated in the figures. The figures on the top show the simulation without the bottom feeder channel flow.



It can be seen that the direction of induced axial currents and that of the cross sectional MHD forces has been reversed in the figures on the bottom by the action of the bottom feeder channel flow. The figures at the bottom also show the electric current streamlines in the plane.

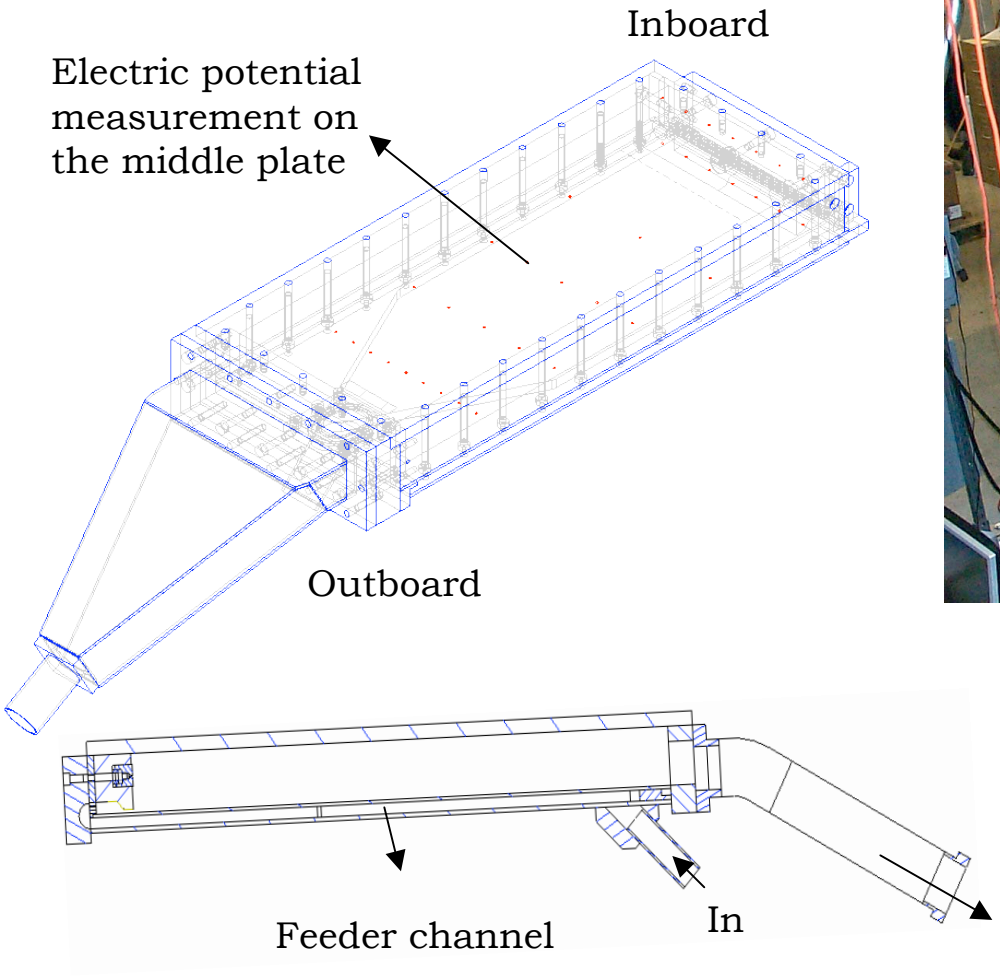


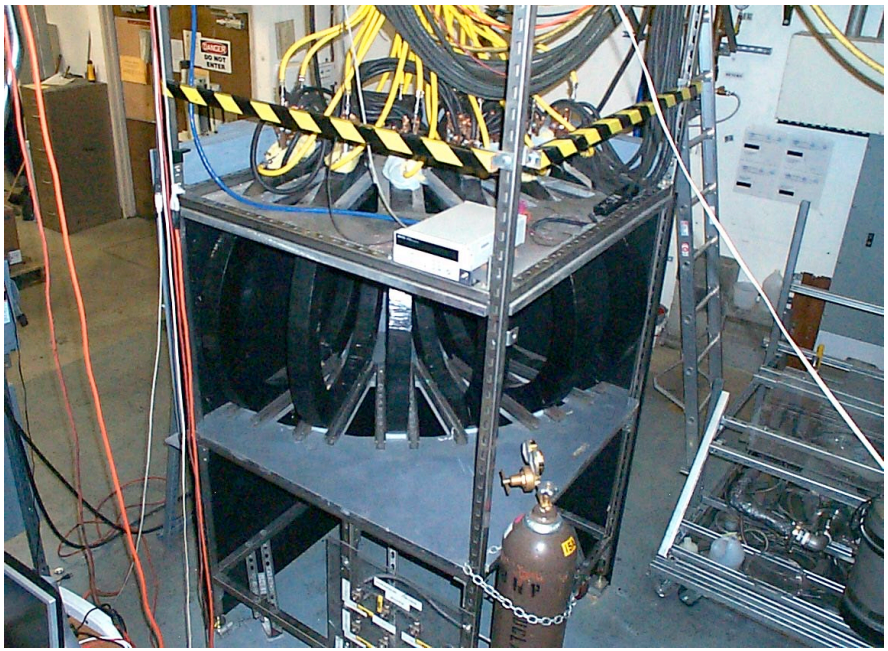


The proposed NSTX LSM lithium film flow configuration is Favorable!

The stream wise variation of axial velocity at the center of the lithium film. The red curve shows the case when the film is made to flow downhill from the outboard towards the inboard in full NSTX divertor magnetic field. The MHD drag on the film in this configuration is significantly enhanced. The green curve shows the case of uphill flow from inboard towards the outboard. The blue curve shows the case of lithium film flow from inboard towards the outboard, coupled with the feeder channel flow (outboard towards inboard)

Experimental Update: The new test section is an “act alike” scaled replica of the proposed LSM with a feeder channel at the bottom and free surface gallium film flow at the top.





The upgraded QTOR magnet. Max field at the inboard = 1.1T

The new test section will be placed inside the QTOR coils to obtain the scaled NSTX toroidal field. For the scaled surface normal field a permanent magnet assembly will be used.

Work to be completed this year

- Numerical Modeling
  - Simulation of wide channel gallium film flow, coupled to bottom feeder channel in the QTOR 3D field, for comparison with the new experiments.
  - Heat transfer analysis of the lithium film flow under NSTX magnetic fields and surface heat flux conditions.
  - Enhance computational capabilities to address plasma current and momentum flux effects on the lithium film flows.

- Experiments
  - Qualitative and quantitative flow behavior in the new “act alike” LSM test article in QTOR fields.
  - Development of electric potential measurement diagnostic and comparison of the obtained electric potential data with the numerical modeling.